

Environmental Effects of Dredging Technical Notes



PHYSICAL MONITORING OF NEARSHORE SAND BERMS

PURPOSE: To provide information for planning a physical monitoring program for contour-parallel nearshore sand berms.

BACKGROUND: Nearshore berms constructed of clean, sandy, dredged material are becoming more popular as Districts and other agencies realize their potential benefits. Monitoring is necessary to ensure that the berms are constructed properly and to assess their behavior. The information presented here supplements information in Technical Note EEDP-01-12 (Clausner 1988) on using sea bed drifters (SBDs) to site and monitor feeder and stable berms.

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Introduction

A nearshore berm consists of dredged sand placed in a long mound in shallow water (usually less than 25 ft), often parallel to shore or bottom contours. Typically they are constructed from maintenance dredged sand using split hull hopper dredges and are 4 to 10 ft high above surrounding topography, 400 to 700 ft wide at the base, and over 5,000 ft long.

Nearshore berms have several advantages over conventional offshore disposal. Often, placing sand close to the inlet from which it was removed may be cheaper than disposal in designated offshore sites or directly on the beach. For example, costs per cubic yard for the various disposal options from Fire Island Inlet, NY, were:

<u>Beach Nourishment</u>	<u>Historical Disposal Site</u>	<u>Feeder Berm</u>
\$5.50 (bid)	\$4.00 (estimated)	\$2.23 (actual)

The historical disposal site was approximately 2 miles from the dredging site and 0.5 mile offshore.

Nearshore berms also have potential benefits for beaches. Since the berm forms a barlike feature, it can dissipate incident wave energy by inducing wave breaking. As the berm disperses over time, it contributes quality sand to the nearshore system. The berm may also act as a partial block to the loss of beach materials to deeper water during storms. A nearshore berm may also move onshore, contributing visible amounts of sand to the dry beach. In this case, the nearshore berm can be termed a feeder berm. However, the research and field experience to define the combinations of sediment characteristics and environmental conditions necessary for onshore movement of sand are not complete. Therefore the term nearshore berm, which only describes where the feature is placed without inferring its ultimate contribution to the littoral system, is generally preferred.

Physical monitoring of nearshore berms involves measuring changes in elevation and volume through successive bathymetric surveys. Most monitoring plans will also include taking sand samples along the berm and possibly on the beach to measure changes in grain size. Beach profiles are often taken to determine changes in response to the berm. Because of the limited experience with nearshore berms, design guidance is not yet available. Consequently, measurement of the driving forces--waves and currents--has been included on some projects.

Physical monitoring is needed to more directly quantify the physical benefits of nearshore berms, verify performance, and check construction. This technical note summarizes the monitoring plans used or proposed for several nearshore berms and concludes with monitoring recommendations for nearshore berms in general.

Biological benefits of nearshore berms are also possible. The major potential benefit would be increasing fisheries value resulting from a change in bathymetry or grain size which may attract other types of fish not normally

found at the site. However, monitoring programs to date have not investigated this aspect, so this technical note will focus solely on physical monitoring.

Monitoring Programs For Existing Nearshore Berms

During 1987, three nearshore berms were constructed--one off Sand Island, AL, and two along the southern shore of Long Island, at Gilgo and Lido Beaches, NY. (The Lido Beach project is not discussed here for lack of available information.) Hands (in preparation) discusses interim monitoring results for the Sand Island nearshore berm. McLellan, Truitt, and Flax (1988) present detailed information on the Gilgo Beach nearshore berm. A nearshore berm was completed off south Padre Island, TX, in January 1989. Monitoring procedures for each project are summarized in Table 1.

Generalized Nearshore Berm Monitoring Guidelines

The following generalized nearshore berm monitoring guidelines have been synthesized from the experiences and recommendations described above. Since the number of berm projects is limited and data analysis continues, modifications to these recommendations are likely. The most important recommendation is to begin the initial monitoring phase as soon as possible after construction is completed. Shallow placement of the berms makes them particularly susceptible to rapid sediment dispersion.

Bathymetry

Bathymetry is the backbone of nearshore berm monitoring, providing volume and elevation change information, and should be included on all projects. Survey lines should be run perpendicular to the berm alignment at a 200-ft spacing, continuing from the breakers, across the berm, out to closure depth. This depth will typically be from 20 to 30 ft on the East and Gulf Coasts, and 30 to 45 ft on the West Coast. Nearshore berms have rarely migrated onshore intact. Instead they have generally dispersed or spread, with the major movement in the along-shore direction. Therefore surveys should extend from a minimum of 1,000 ft updrift of the berm to 2,000 ft downdrift. Preconstruction, immediate

Table 1

Summary of Nearshore Berm Monitoring Activities

<u>Monitoring</u>	<u>Projects</u>		
	<u>Fire Island/ Gilgo Beach, NY</u>	<u>Brazos-Santiago/ Padre Island, TX</u>	<u>Mobile Bay/ Sand Island, AL</u>
<u>Surveys</u>			
Hydrographic Surveys of Nearshore Berm	100 ft spacing between lines. Pre-, mid-, post-, 1 mo, every 2 months.	500 ft spacing between 14 lines, each 3500 ft. Pre-, post-, 1 mo, quarterly.	200 ft spacing between 42 lines, each 2000 ft long. Pre-, every 2 weeks for 2 mo, every 2 months.
Beach Profiles	500 ft spacing. Pre-, mid-, post-, quarterly.	1000 ft spacing, 11 lines. Post-, 6 mo, 12 mo.	None
<u>Sediment Samples</u>			
Nearshore Berm	Pre-, post-, 2 mo.	12 grab, 6-10 cores. Per survey.	31 grab, min. 200 ft apart. Per Survey.
Beach	Pre-, post-, 2 mo.	Undetermined.	None
<u>Waves/Currents</u>	LEO	LEO	Nearshore wave/current gages Offshore wave/meteorological
<u>Side-scan Sonar</u>	None	None	Pre-, two post-surveys.
<u>Seabed Drifters</u>	None	Bundles released from 4 sites, each survey.	Bundles of 50 released from 6 sites, each survey.

(Continued)

Table 1 (Concluded)

<u>Monitoring</u>	<u>Projects</u>		
	<u>Fire Island/ Gilgo Beach, NY</u>	<u>Brazos-Santiago/ Padre Island, TX</u>	<u>Mobile Bay/ Sand Island, AL</u>
<u>Aerial Photography</u>	Pre-, post-, 3 mo.	Post- 1 additional..	2 mo, 7 mo.
<u>Characteristics</u>			
Length (ft)	7,500	5,300	8,000 ft
Width (ft)	500	*	500-700 ft
Elevation (ft)	1-9 ft, 4 ft avg	*	6-8 ft
Amount of Material (cu yd)	420,000 cu yd	225,000 cu yd	464,000 cu yd
5 Water Depth of Base	-16 ft mlw	-22 to -19 ft mlw	-19 ft mlw

* This information still unavailable pending analysis of monitoring data.

postconstruction, and quarterly surveys are recommended, with a minimum of surveys twice per year, e.g., late winter/early spring (March/April) and late summer/early fall (September/October).

Fathometer surveys should be of high quality since the volume percentage of the berm represented by a ± 0.5 ft error band is large. Microwave positioning is a must. Tide corrections, based on a nearby open-water tide gage if possible, are also required, as are vessel squat and speed of sound corrections. Clausner and Hands (1988) and Fredette et al. (in preparation) discuss these surveying and positioning factors in greater detail.

Often the final construction acceptance survey may be used as the initial monitoring survey. If surveys are to be performed by a combination of Field Operating Activities personnel and private contractors, data compatibility and consistency must be assigned. This is particularly true if volume change and elevation data will be analyzed by computer. Figure 1 shows the contours associated with the berm created off Gilgo Beach.

Beach profiles

The need for beach profiles will be a function of the purpose of the nearshore berm. If the nearshore berm is intended to provide beach protection or nourishment, then beach profiles will be needed to quantify the effects. As the depth of the berm increases, probable short-term effects on the beach will

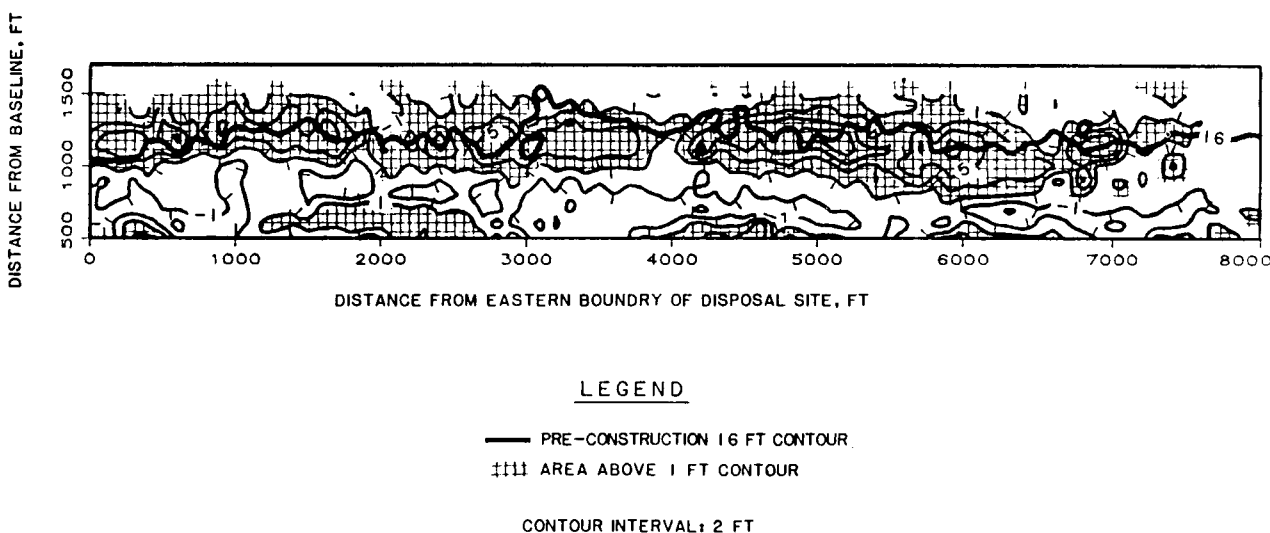


Figure 1. Contour difference plot of Gilgo Beach feeder berm

decrease, reducing the need for frequent beach profiles. If the nearshore berm is intended strictly to save money by reducing haul distances and is being placed where beach erosion is not a problem, beach profiles may not be needed. Nonetheless, potential claims of adverse effects due to the berm probably make it prudent to take a limited number of pre- and postconstruction profiles.

Beach profiles with 500-ft spacing should be adequate for most projects. These profiles should be taken at the same frequency as bathymetry if possible, and should extend updrift and downdrift of the berm. To better define the benefits of a berm, a control section of the beach, some distance away from the berm with similar erosion history, should also be surveyed.

Sea-sled surveys (Clausner, Birkemeier, and Clark 1986) are a highly accurate option to Fathometer surveys. One advantage of sled surveys is that they can measure the profile through the surf zone. In many cases, sled survey lines can easily extend from the subaerial beach seaward across the nearshore berm out to closure depth, allowing monitoring of the entire profile simultaneously.

Sand sampling

Sand samples should be taken and analyzed to help determine migration of the berm. Usefulness of this technique will be reduced if grain-size distributions of the berm and native material are similar. Ten samples per mile of berm, with the samples distributed between the crest and flanks should be sufficient. Samples should be obtained during the bathymetric surveys if possible. Grain-size analysis using 1/4 phi sieves should be obtained for each sample. Control samples from adjacent areas would provide a measure of natural variability.

Short cores can be taken to show depths to which sediments are being worked by waves and currents. Cores can be X-rayed to show sediment reworking and subsampled for grain-size analysis at different elevations. This level of monitoring is not recommended for most nearshore berm projects.

Waves/currents

Measurements of the forces driving movement of nearshore berms are very desirable, but quality long-term measurements of waves and currents are expensive at present. Ideally, directional wave and alongshore current measurements

would be taken both on seaward and landward side of the berm. This should produce data on wave height reduction due to the berm, modification of wave direction due to refraction over the berm, and changes in alongshore/cross-shore currents.

The cost of installing and maintaining instruments, combined with data analysis costs, will generally make these coastal process measurements practical only for a limited number of research efforts such as Sand Island. In addition, as mentioned earlier, fishing/shrimping activities make it difficult to protect gages.

However, a District may plan to use nearshore placement and berm construction repeatedly for maintenance dredged material disposal. Then wave/current measurements from the initial placement could provide input into a numerical model to extrapolate the effects of the waves and currents on the berm for future placements.

A low-cost alternative to instruments are Littoral Environment Observation (LEO) measurements (Schneider 1981). However, LEO data only allow qualitative estimates of wave height, direction, and alongshore currents. Training, supplies, and processing LEO data cost approximately \$3,000 for the first year, and \$2,000 per year for subsequent years.

Sea bed drifters

SBDs are umbrella-shaped, near-bottom current drogues. They are perhaps more useful as devices to help site berms, but can be used on existing nearshore berms to provide insight as to direction of prevailing bottom currents. In addition, public involvement in return of the drifters can generate good, low-cost public relations. McLellan and Burke (in preparation) describe in detail an SBD study used to site the Brazos-Santiago Pass/Padre Island berm. See EEDP Technical Note 01-12 for details on actual use, and Hands (1987) for a review of earlier deep-water SBD studies.

Aerial photography

Aerial photography is standard practice for many monitoring projects. It is not very expensive and gives a continuous picture of the beach. While beach profiles provide much more accurate information on changes, aerial photography can, at low cost, provide information on beach changes for miles beyond the

project boundaries (e.g., accretion at an adjacent jetty fillet). Use of aerial photography to directly monitor the berm is limited to cases of exceptionally clear water or very shallow berms (less than 4 ft).

It is recommended that aerial photography be included in nearshore berm projects. Aerials should be flown at least twice a year (at low tide) at times coinciding with profiles and surveys if possible. Color photography is recommended at a maximum scale of 1:4,800.

Side-scan sonar/subbottom profilers

Side-scan sonar produces an acoustic picture of the bottom, while subbottom profilers produce an acoustic image of sediment layers below the bottom surface. Based on experiences at Sand Island, neither instrument is recommended for monitoring nearshore berms in general. Both of these instruments are discussed in greater detail in EEDP Tech Note 01-10 (Clausner and Hands 1988).

Diver observations

Diver observations are probably not required for general nearshore berm monitoring. Divers can give information on small-scale processes and biological activity, take short cores, and maintain bottom instrument packages. However, their expense is probably not justified for most projects.

Wind

Wind data may prove useful in supplementing nearshore current observations by providing a measurement of this primary driving force. Wind data are often useful in interpreting SBD movements. If it appears that wind data should be used in interpreting nearshore berm performance, availability of wind data from local airports, the National Climatic Data Center, and local Coast Guard Stations should be checked.

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